THE PLEISTOCENE SUCCESSION NEAR ALTON, ILLINOIS, AND THE AGE OF THE MAMMALIAN FOSSIL FAUNA

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Some time previous to 1883 the late Honorable William McAdams, an ardent naturalist of Alton, Illinois, collected a number of mammalian remains from the Quaternary deposits of the Mississippi bluffs near his home city. The specimens found their way to the United States National Museum at Washington, where they have been studied by Dr. O. P. Hay. The collection includes remains of a ground sloth, horse, peccary, a large deer, moose, reindeer, eland, musk ox, mastodon, beaver, ground hog, pouched gopher, and brown bear.[1] Their importance became obvious when some of the individuals were found to represent new species, and therefore it was especially desirable to ascertain if possible their stratigraphic horizon.

The attention of the writer having been called to this collection through the kindness of Doctor Hay, arrangements were made with the Illinois Geological Survey for a few days' study with the hope of finding the exact locality and horizon, and of determining the place of the deposits in the Quaternary series. The deposits proved to be so suggestive of new interpretations that this preliminary paper has been prepared.

Previous literature.—In 1882 A. H. Worthen noted the finding of a portion of the jawbone of a mastodon in the lower part of the loess just northwest of the city of Alton.[2] In 1883 McAdams published an abstract of a paper in the *Proceedings of the American*

[1] O. P. Hay, personal communication.

[2] A. H. Worthen, "Geology of Madison County," *Economical Geology of Illinois*, Vol. I (1882), p. 252.

Association for the Advancement of Science which he read at the Minneapolis meeting. Quoting from this paper[1] we read:

> The drift clays proper at Alton, Illinois, had a maximum thickness of about one hundred feet, and the bluff clays were nearly of the same thickness. These clays were remarkably rich in animal remains, such as teeth and bones, attached to calcareous nodules or claystones. Remains of thirteen different species, now perhaps all extinct, had been found. The rodents were well represented by bones of seven species, including three or more beavers and some gophers. Nearly seventy teeth were found in the Quaternary deposits, a majority of them in a single quarry.

The locality.—The bluffs northwest of Alton have a height of from 125 to 175 feet above the Mississippi River. Approximately 75 to 125 feet of the section is Mississippian limestone, while the overlying material consists largely of loess with a thin deposit of glacial till in places separating the loess from the limestone. The upper surface of the limestone is somewhat uneven, but the cliffs persist for many miles up the river. Just east of Alton the Mississippian formations give way to the Pennsylvanian sediments. The upland of the western part of the city is characterized by karst topography, due to the solvent action of ground water on the underlying Mississippian limestone.

Section at one of the quarries.—At Plant No. 2 of the Mississippi Lime and Material Company, northwest of the roundhouse, the following section was found:

	Feet
Soil, loessial, dark brown, leached	1
Loess, brownish at the top, grading below within a few feet into buff; leached 4 to 5 feet below the soil; calcareous below, with a few loess fossils scattered through the deposit; stands with steep face in fresh cuts; maximum thickness . . . . . about	20
Loess distinctly more reddish than the overlying, strongly suggesting a distinct deposit; contains many fossil snails, some "pipestem" concretions; has a silty texture but not sandy; maximum thickness . . about	30
Glacial till, reddish, contains many erratic pebbles of granite, dolerite, greenstone, quartzite, and other Canadian rocks, and also some local rocks, mostly subangular, some	

[1] *Proc. A.A.A.S.*, Vol. XXXII (1883), pp. 268–69.

rounded. The till is much more oxidized than the overlying loess. In the contact zone between the till and the loess are the lime concretions from which the mammalian remains were obtained.[1] Thickness . . .	1–3
Limestone, Mississippian age, about	100

Salient points regarding the drift.—As noted above, the glacial till exposed at this quarry is very thin and much more oxidized than the overlying loess. At the next quarry to the northwest, a patch of glacial till about 12 feet thick lies beneath the loess, strikingly set off from the loess above by a chocolate brown, weathered zone. The face of the exposure above the limestone cliff was too precipitous to admit of detailed study, but in the succeeding quarry to the northwest, at Plant No. 3 of the Mississippi Lime and Material Company, near the northeast end of the quarry, 18 feet of till above the limestone and below fossiliferous loess was accessible for study.

The till is a typical pebbly clay till. Its top is rounded and marked by a pebble band. The till is also oxidized to dark brown, changing below within a few feet to a yellowish brown to yellow color. The matrix of the till and the limestone pebbles are leached for about 8 feet down from the summit of the till, but where the slope of the till cuts down to a lower level this leached zone is diminished to about 3 feet. Beneath, the till is highly calcareous, and contains lime concretions up to about 8 inches in diameter. No such concretions occur in the overlying loess. The drift breaks into small polyhedral forms, due to the numerous intersecting joints. The surfaces of these joints are coated with oxide of manganese.

Age of the drift.—That the drift is much older than the loess is clearly shown by the weathered zone at its top. Its geographic location brings it within the possibility of being Illinoian in age; but there are strong suggestions that it may be as old as the Kansan. The 8-foot depth of the leached zone beneath fossiliferous and calcareous loess, the chocolate brown color of the upper part of the oxidized zone, the coating of manganese dioxide along the numerous joints which transect the till body, and the large concretions

[1] Fortunately the writer was able to have Mr. John D. McAdams, son of the collector, verify the horizon and the concretions as the source of the fossils.

in the calcareous zone, representing a concentration of part of the lime formerly in the upper portion, are somewhat extreme for drift of Illinoian age, underlying calcareous loess. The significance of these evidences seems even greater when one takes note of the pebble band at the top and the rounded summit which indicate the removal of an unknown amount of the leached drift. That this erosion was considerable and took place before the deposition of the loess is further suggested by the patchy distribution of the drift.

The evidences of great age stimulate a search for the nearest known Kansan drift. Drushell describes several exposures of much weathered drift, believed to be Kansan, in St. Louis.[1] And Fenneman states that the vicinity of St. Louis "apparently contains the thin edge of the Kansan drift sheet," as well as that of the Illinoian drift.[2] The Kansan drift of northern Missouri being in the Keewatin field, the question arises as to whether the remnants of drift at Alton may not record the movement of the Kansan ice across the site of the present Mississippi Valley. An examination of the petrology of the Alton deposits, made with the capable help of Dr. T. T. Quirke, supports an affirmative answer. None of the pebbles, so far as known, is distinctively from ledges in the Labrador field, whereas, all of them may well have come from formations in the Keewatin field, a few strongly suggesting native ledges at the west end of Lake Superior.

Some negative evidence, however, is to be considered. Leverett has observed two occurrences of glacial striae on bedrock at Alton, whose trend is S. 30°–40° W.[3] Although referred to the Illinoian ice, they were probably made by whatever glacier deposited the overlying till. If the drift is Kansan and of Keewatin relationship, the ice lobe in northern Missouri must have radiated until the eastern peripheral part moved in a northeasterly direction (E. 50°–60° N.)—a seemingly extreme departure from the main movement

[1] *Jour. Geol.*, Vol. XVI (1908), pp. 493–98.

[2] "Geology and Mineral Resources of the St. Louis Quadrangle," *U.S. Geol. Survey*, Bulletin 438, p. 31.

[3] Frank Leverett, "The Illinois Glacial Lobe," *U.S. Geol. Survey*, Monograph XXXVIII (1899), pp. 86–87.

of the lobe. Hence, from this standpoint, it seems better to credit the striæ to an ice sheet coming from the northeast, and to inquire into this possibility.

Pre-Illinoian drift in the Labrador field has been identified in surface exposures in the western part of the La Salle quadrangle and the eastern part of the Hennepin quadrangle.[1] Drift below the Illinoian has also been reported in a recent well in the Springfield region.[2] Such drift is far enough east of the known limits of the Keewatin field to be best referred to the work of a glacier in the Labrador field having a general southwesterly movement in Illinois. But, as pointed out above, the materials collected from the Alton deposits do not show anything distinctively Labradorean in origin. More data must be awaited to settle definitely the age of the drift concerned.

The loess deposits.—As given in the section described above there are two deposits of loess in this region, separable at least on the basis of color. The lower loess is characterized by its reddish tinge, the upper by its buff color. At all of the fresh exposures of the several quarries at Alton, this difference is conspicuous, and this is found to hold not only for street cuts in other parts of the city but for more distant localities. Buff loess overlying reddish loess is shown at the quarries at Grafton, 18 miles up the river, and at Edgewood, about 25 miles down the river. At Alton the reddish loess is somewhat thicker than the buff, the former being about 30 feet thick, the latter about 22 feet. Approximately the same ratio holds true at Grafton, but at Edgewood the conditions of slope do not favor a good estimate. Both are fossiliferous, but on the whole the lower seems to contain more shells than the upper. The fossil content will be discussed later. In texture, both seem to be typical loess, with no notable quantity of sand or suggestion of stratification.

Both are doubtless aeolian in origin, their relations to the Mississippi Valley indicating its flood plain as the chief source of

[1] Gilbert H. Cady, "Geology and Mineral Resources of the Hennepin and La Salle Quadrangles," *Bulletin 37* (1919), p. 71.

[2] E. W. Shaw, and T. E. Savage, "The Tallula-Springfield Quadrangles," *U.S. Geol. Survey*, Folio No. 188 (1913), p. 7.

supply. The distinctness between the two in color remains to be explained. Three working hypotheses may be tested. (1) The difference in color is original, the lower having been derived from a reddish silt, the upper from a buff silt. (2) The difference in color was brought about by weathering of the lower loess before the upper was deposited. (3) The lower was deposited under climatic conditions which favored oxidation to a reddish tinge during accumulation and then with a change in climate the succeeding deposits were not so highly oxidized, only a buff color being produced. The first and third hypotheses do not necessarily imply a distinct interval between the two stages of deposition, while the second, of course, does. A solution was sought in the nature of the contact, the evidences of weathering, and the fossil content.

1. *Character of the contact.*—In perhaps most places the contact between the two loesses is gradational, the gradation, however, taking place within a few inches. At first glance, this might be taken to record continuous deposition. But such an interpretation must not be held too rigidly in the case of wind deposits, since materials of an old surface may be mixed with new sediments, either by the wind itself or by organic agencies, thereby obscuring the record of an interval.

2. *Difference in oxidation.*—The reddish tinge of the lower loess is somewhat greater at the top than lower down in this deposit, although the reddish tinge characterizes the whole deposit. The stronger color at the top of the lower loess suggests an interval of weathering before the deposition of the overlying, but the reddish tinge throughout must be otherwise explained.

3. *Differences in content of lime carbonate.*—If the lower loess was subjected to weathering, it should show evidence of leaching of lime carbonate. The acid test revealed the presence of some lime carbonate throughout the reddish loess and into the overlying buff loess, but the reaction was notably feebler in the top of the reddish loess than in the base of the buff. While not strong, this evidence is suggestive of at least a brief interval of weathering between the two loess epochs although it is realized that there may have been an original difference in the lime content of the two loesses. Some of the larger shells, such as the *Polygyras* which extend from bottom

to top in the lower loess, are more fragile in the upper part, thus strengthening the evidence of leaching.

4. *Bearing of the fossil content.*—A small collection of fossils from each of the two loesses was made, and these have been examined by Curator Frank C. Baker of the Museum of Natural History, University of Illinois. The fact that the collection was not exhaustive limits the conclusions that may be drawn as to the fossil differences between the two deposits. However, two points seem to be clear: first, the lower loess has notably more fossils than the upper; and secondly, the large *Polygyras*, so characteristic of the lower deposit, do not seem to pass into the upper. Two of these *Polygyras* have been designated new varieties by Professor Baker; one, *Polygyra profunda pleistocenica*, is smaller than the normal species of today, and the other, *Polygyra multilineata altonensis*, is larger than its living representative. These and some of the other forms are described in a paper by Professor Baker.[1] If these should be found to be limited to the lower loess, the fact might indicate some climatic condition of unusual character.

From the foregoing evidence it would seem that a brief epoch intervened between the deposition of the reddish loess and the buff loess, but that the difference in color is not wholly due to this epoch of weathering. There is the possibility that the reddish tinge was given the lower loess by oxidation during the period of accumulation, but this would imply a climate of rather moist and dry extremes. The helices of the lower loess, such as *Polygyra profunda* and *multilineata*, according to Baker, are fond of relatively damp places in forest litter, beneath old logs and rubbish, and hence seem to be negative evidence. However, the *Polygyras* of this deposit have variational differences from these types, and these differences may be significant in this respect, although this is conjecture. The alternative view that the reddish tinge is due to the original color of the silts which were then present on the Mississippi flood plain, is somewhat favored. Reddish silts beneath loess are known upstream at least on the Iowa side where they are described as "red loam."[2] The writer has also observed "slack-

[1] *Nautilus*, Vol. XXXIV (1920), pp. 61–66.

[2] W. H. Norton, "Geology of Scott County," *Iowa Geol. Survey*, Vol. IX (1899), pp. 486–88.

water" silts of various colors, including maroon, in a tributary to the Mississippi River near Clinton, Iowa. Although these silts are believed to be younger than the "red loam," they help to show that the Mississippi has carried reddish silts at different times.

The age of the loesses.—The occurrence of the loess on the weathered till shows that for a long time after the deposition of the glacial till there was no loess in this vicinity. If the drift is Kansan in age, the reddish loess may be Sangamon; if, on the other hand, the drift be Illinoian, the reddish loess probably is Peorian. It is unlike any Peorian loess of which the writer knows, but the color does not necessarily preclude that possibility.

The upper buff loess is leached to a depth of 5–6 feet from the surface—an amount not exceeding some instances of leaching of loess on the Early Wisconsin. However, the summit is somewhat rounded, favoring some slope-wash, and hence this figure probably does not represent the total amount of leaching. According to Curator Baker, one species (*Pyramidula shimekii*), typical of the Early Peorian loess,[1] occurs in the collection taken from the buff loess but not in that from the reddish loess. The thickness is unusual for post-Wisconsin loess, but its proximity to the Mississippi makes this possibility plausible. Thus, the evidence in hand is not decisive as to whether the upper buff loess is Peorian or Early Wisconsin. If the reddish loess is Sangamon in age, the absence of a record of a long interval between its deposition and that of the overlying buff loess would seem to tie the two rather closely and favor the Early Peorian age of the upper loess.

The mammalian fossil horizon.—Mr. McAdams reported the mammalian fossils to be associated with calcareous concretions in the lower part of the loess.[2] They occur, however, at the base of the loess and the top of the till. Scores of concretions were broken open and examined in the hopes of finding more fossil remains, but reward was had in but one specimen, which contained a remnant of the lower portion of some tooth of an unknown mammal. A quarryman at Plant No. 2 reported that in the summer of 1919 a

[1] Formerly called Iowan loess, but recently pointed out as Early Peorian in age: "The Iowan Drift a Review of the Evidences of the Iowan Stage of Glaciation,," *Iowa Geol. Survey*, Vol. XXVI (1917), pp. 140–64.

[2] *Proc. A.A.A.S.*, Vol. XXXII (1883), p. 268.

fragment of a jawbone with teeth was found attached to a concretion when the overlying clay was being washed away by the hydraulic method. Unfortunately, the specimen was not saved.

The concretions range in size commonly from 1 inch or less to 5 and 6 inches in their longest diameter. Some include *Polygyra* shells, characteristic of the lower loess from bottom to top, while others contain pebbles of the underlying drift. A large percentage of each concretion appears to be of very fine material, which has given them the name of "loess nodules," although they do not occur strictly in the loess. They are secondary, younger than both drift and loess, their content of lime having been dissolved from the overlying formations which, together with the finely divided material of the loess carried probably in the colloidal state, has been deposited in concretionary form in the contact zone between the loess and the drift. In the forming of some of these concretions some of the pebbles in this zone were included, and, in some instances, mammalian remains.

Composition of the fauna and its age.—The following is a list of species which have been identified by Dr. Hay[1] in the McAdams collection:

Megalonyx jeffersonii	Extinct ground sloth
Equus sp. indet.	Extinct horse
Platygonus cumberlandensis?	Extinct peccary
Sangamona fugitiva	Large extinct deer
Cervales roosevelti?	Extinct moose
Rangifer muscatinensis?	Extinct reindeer
Taurotragus americanus	Extinct American eland
Symbos promptus	Extinct musk ox
Mamut americanum	Extinct mastodon
Castor canadensis	Canadian beaver
Castoroides ohionensis	Extinct giant beaver
Marmota monax	Ground hog
Geomys bursarius	Pouched gopher
Ursus americanus	Brown bear

The quarry from which most of the remains were secured shows a gentle depression at the top of the limestone, as if the surface of the limestone led to a sink, such as characterizes the karst topography of the upland directly back from the quarries. An examination of two of these sinks revealed their origin to be joint

[1] Personal communication.

planes widened by solution. At the quarry, several solution channels are well exhibited and the faces of the rock along the joints are in some instances coated with travertine, and in others with silt or clay which has been carried down from the surface. The clogging of these subterranean channels would give rise to ponds in the surface sinks, modern examples of which occur a short distance north of Plant No. 3 of the Mississippi Lime and Material Company. Such situations may have existed during the Pleistocene, and if so, offered favorable conditions for the entrapment of the region's fauna of both water and land species.

The fossil fauna, according to Baker, contains certain elements which suggest the arctic phase of a glacial epoch and other elements which belong to the warm phase of an interglacial epoch. The remains, however, could not have lain on the drift during the long period of weathering which followed the deposition of the drift. Hence, it is thought the remains of the arctic elements are a record of the life which lived in the latter part of the next glacial epoch, while the remains of the warm fauna represent the life which lived at the beginning of the interglacial epoch following that glacial epoch. As the melting of the ice sheet was a response to the change of climate from cold to warm, it is believed that with the local disappearance of the ice sheet, the warm interglacial fauna succeeded the arctic before the deposition of the reddish loess.

If the till proves to be Kansan in age, the weathering of the drift may be credited to the Yarmouth interglacial epoch, the mammalian fauna to late Illinoian and early Sangamon times, the reddish loess probably to the Sangamon, and the buff loess to the Iowan. If, however, the till is Illinoian, then the fauna probably is a partial record of the life of the latter part of the Iowan glacial epoch and the early Peorian interglacial epoch. In the latter case, the writer finds some difficulty in assigning both loesses to the Peorian, or in referring the upper buff loess to post-Wisconsin times. However this may be, the Illinoian and Sangamon epochs are post-mid-Pleistocene, from the standpoint of the duration of the Pleistocene, and the fauna represented by the McAdams collection may be regarded as post-mid-Pleistocene.